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1980
AIR MONITORING REPORT
CITY OF CALGARY

Alberta
ENVIRONMENT

1980
Air Monitoring Report
City of Calgary

prepared by

AIR QUALITY CONTROL BRANCH

POLLUTION CONTROL DIVISION

ENVIRONMENTAL PROTECTION SERVICES

ALBERTA ENVIRONMENT

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SYNOPSIS

This report is an assessment of the ambient air quality in the city of Calgary for the 1980 report year. The assessment is based on the results of the monitoring of various air pollutants by the Air Quality Control Branch of the Pollution Control Division of Alberta Environment from March 1, 1980 to February 28, 1981.

The emphasis is on comparing the data with the levels outlined in the Alberta Clean Air (Maximum Levels) Regulations.

The air quality indices--numerical indicators of air quality, which are based on readings of sulphur dioxide, ozone, carbon monoxide, suspended particulate matter, and nitrogen dioxide--are also discussed in this report. Generally, the air quality was in the 'good' index range.

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I. INTRODUCTION

The Air Quality Control Branch of Alberta Environment operates an on-going program of ambient air monitoring in the city of Calgary. The objectives of this program are twofold: to provide data for the assessment of existing air quality; and to establish long-term trends in air quality. To achieve these goals, the Branch operates a comprehensive network of stations equipped to measure oxides of nitrogen, ozone, carbon monoxide, sulphur dioxide, total hydrocarbons, particulates and total sulphation.

The report summarizes the results of the monitoring of these air pollutants from March 1, 1980 to February 28, 1981. This period was chosen because it reflects the seasonal fluctuations of air pollution levels. The seasonal breakdown is as follows: Spring - March, April, May; Summer - June, July, August; Fall - September, October, November; Winter - December, January, February.

The data obtained during this report year are compared with the air quality Regulations, which stipulate the maximum permissible concentrations of contaminants in the ambient air as listed in the Alberta Clean Air (Maximum Levels) Regulations.

The "Source and Emission Inventories" for the pollutants are cited to provide information on the contribution of each major source (e.g. industry and motor vehicles) to the total emissions of each pollutant.

II. THE AIR MONITORING NETWORK

The network of air monitoring stations in the city of Calgary is comprised of two units: the continuous ambient air monitoring network, which collects data on oxides of nitrogen, ozone, carbon monoxide, sulphur dioxide and total hydrocarbons; and the static and intermittent air monitoring network, which samples total sulphation and particulates - soiling index, suspended particulate matter (high volume sampler) and total dustfall.

Figure 1 illustrates the locations of the three continuous air monitoring stations. The stations are designated CDMU, CRMU and CIMU. The designations refer to the general locations of the stations in the downtown, residential and industrial areas respectively. Table 1 lists the parameters that each station is equipped to monitor continuously and gives additional information about the stations.

The locations of the static and intermittent air monitoring stations are also shown in Figure 1. This network of stations is comprised of 28 exposure sites for measuring total sulphation and total dustfall, and three sites for measuring soiling index and suspended particulate matter.

FIGURE 1

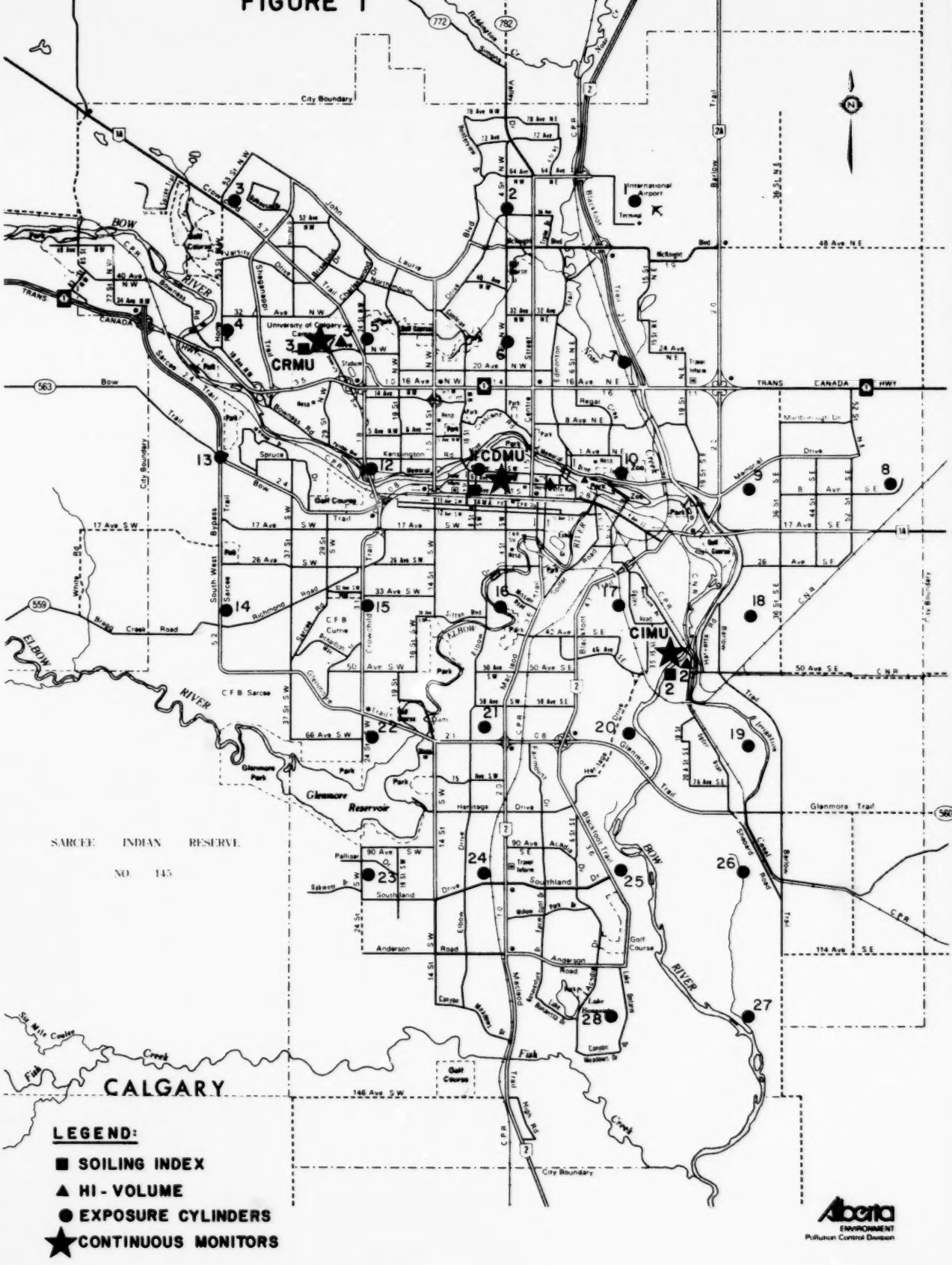
CRMU
CDMU
CIMU
CALGARY
SARCEE INDIAN RESERVE NO. 145
City Boundary
CANADA
TRANS
Bow River
Elbow River
Glenmore Reservoir
Fish Creek
Sixmile Coulee Creek
Bow Trail
Glenmore Trail
Anderson Road
Southland Drive
Heritage Drive
Richmond Road
Crowchild Trail
Blackfoot Trail
Deerfoot Trail
Macleod Trail
Barlow Trail
Stoney Trail
Memorial Drive
17 Ave S.W.
16 Ave N.E.
50 Ave S.E.
114 Ave S.E.
146 Ave S.W.
International Airport
University of Calgary
CFB Currie
CFB Sarcee
LEGEND:
SOILING INDEX
HI-VOLUME
EXPOSURE CYLINDERS
CONTINUOUS MONITORS
Alberta
ENVIRONMENT
Pollution Control Division

TABLE 1

THE CONTINUOUS AMBIENT AIR MONITORING NETWORK

Parameters that Stations are Equipped to Monitor Continuously

Station	Wind	NO_x	NO_2	O_3	CO	SO_2	THC
CDMU	-	x	x	x	x	x	x
CIMU	x	x	x	x	x	x	x
CRMU	x	x	x	x	x	x	x

Note: CDMU - Calgary Downtown Monitoring Unit
CIMU - Calgary Industrial Monitoring Unit
CRMU - Calgary Residential Monitoring Unit

NO_x - Oxides of Nitrogen
NO_2 - Nitrogen Dioxide
O_3 - Ozone
CO - Carbon Monoxide
SO_2 - Sulphur Dioxide
THC - Total Hydrocarbons

Station Documentation

Station	Station Address	Height of Station	Height of Sample Inlet Above Ground
CDMU	4 St. and 6 Ave. S.W.	4 m	6 m
CIMU	18A St. and 45 Ave. S.E.	3 m	4 m
CRMU	39 St. and 29 Ave. N.W.	3 m	4 m

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Air Quality Control Branch

III. THE AIR MONITORING INSTRUMENTATION

The detection principles and sampling periods of the pollutants monitored during the 1980 report year are presented in Table 2. Also included are the methods used to calibrate the instruments and the type of monitoring that was employed for each pollutant.

There are three basic types of ambient air monitoring, and they differ on the basis of the duration of the sampling periods: continuous, static and intermittent. Continuous monitoring is the sampling of the air on a continuous basis; static monitoring involves time periods of approximately 30 days; and intermittent monitoring encompasses 1-hour, 2-hour and 24-hour sampling time periods.

Monitoring of ambient air may also be categorized according to the method used for analyzing the sample, automatic or manual. Automatic analysis is accomplished by a system which has the capability of collecting the sample, analyzing it and giving a data read-out. This is exemplified by the monitoring of oxides of nitrogen, ozone, carbon monoxide, sulphur dioxide and total hydrocarbons. Manual analysis involves the collection of a sample and subsequent analysis at a laboratory. The monitoring of particulates and total sulphation are examples of the manual method.

TABLE 2

THE AIR MONITORING INSTRUMENTATION

Pollutant	Detection Principle	Sampling Period	Type of Monitoring	Instrument Calibration Method
Nitrogen Dioxide	Chemiluminescence	Instantaneous (sample integration)	Continuous	Permeation tube or Gas Phase titration
Ozone	Chemiluminescence or Ultraviolet photometry	Instantaneous (sample integration)	Continuous	Buffered potassium iodide or Gas phase titration
Carbon Monoxide	Nondispersive infrared radiation	Instantaneous (sample integration)	Continuous	Certified gas cylinder
Sulphur Dioxide	Coulometric detection or Pulsed fluorescence	Instantaneous (sample integration)	Continuous	Permeation tube
Total Hydrocarbons	Flame ionization	Instantaneous (sample integration)	Continuous	Certified gas cylinder
Suspended Particulate Matter (Soiling Index)	Tape sampler (light transmittance)	1-hour or 2-hour	Intermittent	Rotameter - flow
Suspended Particulate Matter (High-Volume Sampler)	Gravimetry	24-hour	Intermittent	Orifice plates/mass flow detection
Total Sulphation	Chemical reaction	30 days	Static	N/A
Total Dustfall	Gravimetry	30 days	Static	N/A

Alberta ENVIRONMENT Pollutant Control Division Air Quality Control Branch

IV. AIR POLLUTANT DATA ANALYSES

A. INTRODUCTION

In this section of the report, the pollutants are examined on an individual basis. The presentation includes general information on the pollutants, an overview of the prime emission sources as determined by the 1973 Source and Emission Inventory and an analysis of the data.

For the purposes of this report, the data are summarized. The summaries include arithmetic mean concentrations and the frequency of occurrence of concentrations in compliance with the Clean Air (Maximum Levels) Regulations.

Sufficient data must be available to constitute valid calculated mean values. When the instrument operational time is less than 50%, no arithmetic mean is calculated; and when the instrument is operational between 50% and 75% of the time, the arithmetic mean may not be representative of that period. Therefore, any comparisons of the data should take this into account.

Tables 3 and 4 are included to provide an overall picture of existing air quality and to give some idea of the trends of the air pollution levels over the past five years. Starting with the 1982 annual report, a detailed trend analysis section will be included.

TABLE 3

POLLUTANTS COMPARED WITH CLEAN AIR REGULATIONS[1]

March 1, 1980 - February 28, 1981

POLLUTANT	PERCENT COMPLIANCE WITH REGULATIONS[1]			AIR QUALITY REGULATIONS
	CDMU	CIMU	CRMU	
Nitrogen Dioxide				
1-hour	99.98	100	99.99	0.21 ppm
24-hour	100	100	100	0.11 ppm
Ozone				
1-hour	100	100	99.98	0.080 ppm
24-hour	90.21	92.38	68.24	0.025 ppm
Carbon Monoxide				
1-hour	99.12	99.68	99.93	13.0 ppm
8-hour	94.13	97.20	98.97	5.0 ppm
Sulphur Dioxide				
1-hour	100	100	100	0.17 ppm
24-hour	100	100	100	0.06 ppm
Suspended Particulate Matter (Soiling Index-COH)	100	91.71	100	A minimum of 90% of readings per month shall be less than 1.0 COH.
Suspended Particulate Matter (High-Volume Sampler)	22.95	34.55	48.21	100 $\mu g/m^3$/24hr
Total Dustfall[2]				
Residential and Recreational Area Stations		48.70		53 mg/100 cm^2/30 days
Commercial and Industrial Area Stations		88.98		158 mg/100 cm^2/30 days

[1] Clean Air (Maximum Levels) Regulations.
[2] No allowance made for normal background levels as required by (1).

Alberta ENVIRONMENT
Pollution Control Division
Air Quality Control Branch

TABLE 4

ANNUAL CONCENTRATION MEANS IN CALGARY
(1976-1980)

		1976	1977	1978	1979	1980
Nitrogen Dioxide (ppm)	CDMU	0.04	0.04	0.04	0.05	0.04
	CIMU	0.03	0.03	0.03	0.03	0.02
	CRMU	0.02	0.02	0.03	0.02	0.02
Ozone (ppm)	CDMU	0.012	0.012	0.014	0.013	0.012
	CIMU	0.016	0.013	0.012	0.018	0.013
	CRMU	0.026	0.021	0.022	0.023	0.021
Carbon Monoxide (ppm)	CDMU	2.2	2.5	2.7	2.8	2.3
	CIMU	1.8	1.6	1.5	1.5	1.4
	CRMU	1.3	1.4	1.1	1.2	1.0
Total Hydrocarbons (ppm)	CDMU	2.2	2.4	2.4	2.9	2.2
	CIMU	2.0	2.0	2.1	2.0	2.2
	CRMU	1.6	2.0	2.0	2.1	1.8
Total Sulphation 28 Stations (SO_3 equiv. mg/100cm^2/day)		0.12	0.16	0.16	0.15	0.24
Suspended Particulate Matter Soiling Index (COH Units)	CDMU	0.16	0.19	0.24	0.25	0.32
	CIMU	0.23	0.21	0.21	0.26	0.30
	CRMU	0.09	0.12	0.09	0.11	0.11
Suspended Particulate Matter High-Volume Sampler µg/m^3 (Geometric Mean)	CDMU	109	79	98	130	168
	CIMU	94	91	103	143	156
	CRMU	46	53	49	61	77
Total Dustfall						
Residential and Recreational Area Stations (17) mg/100 cm^2/30 days		60	56	56	58	65
Commercial and Industrial Area Stations (11) mg/100 cm^2/30 days		77	84	63	76	92

B. OXIDES OF NITROGEN (NO_x)

Oxides of nitrogen are composed of two major constituents: nitrogen dioxide (NO_2) and the less toxic nitric oxide (NO). Both pollutants originate from natural and man-made processes. Nitrogen and oxygen, the principle constituents of the atmosphere, combine during high temperature combustion to form NO_x.[1] The major man-made source is from the burning of fossil fuels such as natural gas, coal, oil and gasoline.

In the city of Calgary, motor vehicles contribute about 65% of the oxides of nitrogen emissions, industry contributes about 18 percent, and natural gas combustion from sources such as home heating contributes 17 percent (Figure 2 - "Source and Emission Inventory").

The major oxide of nitrogen at the point of combustion is nitric oxide. A small fraction of the nitric oxide is converted to nitrogen dioxide by photochemical oxidation. Since it has been demonstrated that nitrogen dioxide can cause deleterious effects, and is the more toxic oxide of nitrogen, the emphasis here will be placed on nitrogen dioxide.

Nitrogen dioxide is an orange-brown gas with a characteristic pungent odour. Because of its colouration, it has been postulated that NO_2 is responsible for a portion of the brownish discolouration of air masses near urban areas.

The results of the monitoring of NO_2 during the 1980 report period are presented in Table 5 and Figure 2. All nitrogen dioxide readings were 100% in compliance with the Regulations, with the

exception of 99.9% compliance with the 1-hour Regulation at CDMU in March 1980 and October 1980, and at CRMU in October 1980. Vehicular traffic exhaust is responsible for the small amount of non-compliance time.

TABLE 5
NITROGEN DIOXIDE/OXIDES OF NITROGEN

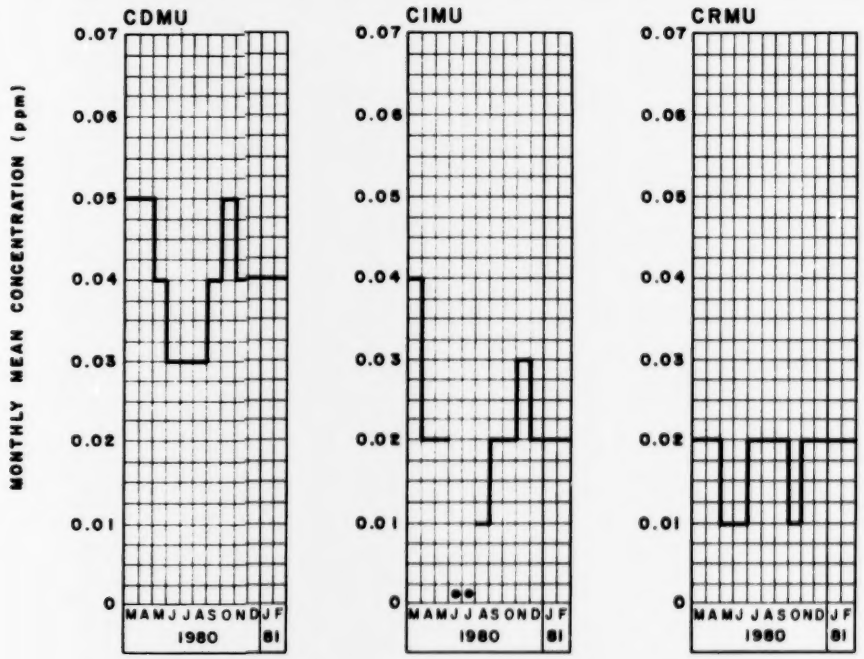
MAXIMUM LEVELS REGULATIONS(NO_2)
1-HOUR-0.21 PPM 24-HOUR-0.11 PPM

MONTH	ARITHMETIC MEAN (ppm)		PERCENTAGE OF TIME INSTRUMENT OPERATIONAL		PERCENT COMPLIANCE WITH NO_2 REGULATIONS	
	NO_2	NO_x	NO_2	NO_x	1-HR	24-HR
CDMU						
March '80	0.05	0.09	97.6	97.8	99.9	100
April	0.05	0.07	96.5	96.5	100	100
May	0.04	0.06	98.3	98.3	100	100
June	0.03	0.05	97.8	97.8	100	100
July	0.03	0.05	98.7	98.7	100	100
August	0.03	0.05	98.4	98.8	100	100
September	0.04	0.08	95.0	97.5	100	100
October	0.05	0.10	99.3	99.3	99.9	100
November	0.04	0.11	98.1	98.6	100	100
December	0.04	0.10	90.3	90.3	100	100
January '81	0.04	0.12	98.3	93.4	100	100
February	0.04	0.10	98.4	99.1	100	100
CIMU						
March '80	0.04	0.08	90.1	93.4	100	100
April	0.02	0.05	97.9	97.6	100	100
May	0.02	0.03	93.1	93.7	100	100
June	a	a	49.7	49.7	100	100
July	a	a	16.1	16.1	100	100
August	0.01	0.03	56.6	56.6	100	100
September	0.02	0.04	98.2	98.2	100	100
October	0.02	0.08	98.5	98.5	100	100
November	0.03	0.11	98.5	98.5	100	100
December	0.02	0.10	100	100	100	100
January '81	0.02	0.11	98.8	98.8	100	100
February	0.02	0.07	99.0	98.8	100	100
CRMU						
March '80	0.02	0.03	94.5	94.5	100	100
April	0.02	0.02	98.2	98.2	100	100
May	0.01	0.01	96.9	92.6	100	100
June	0.01	0.01	77.9	77.9	100	100
July	0.02	0.02	95.6	95.6	100	100
August	0.02	0.02	98.8	98.8	100	100
September	0.02	0.03	97.9	98.3	100	100
October	0.01	0.04	99.2	99.2	99.9	100
November	0.02	0.04	96.1	98.8	100	100
December	0.02	0.04	98.7	98.7	100	100
January '81	0.02	0.05	99.3	99.3	100	100
February	0.02	0.04	94.9	94.9	100	100

a - Instrument operational less than 50%; insufficient data for calculation of mean.

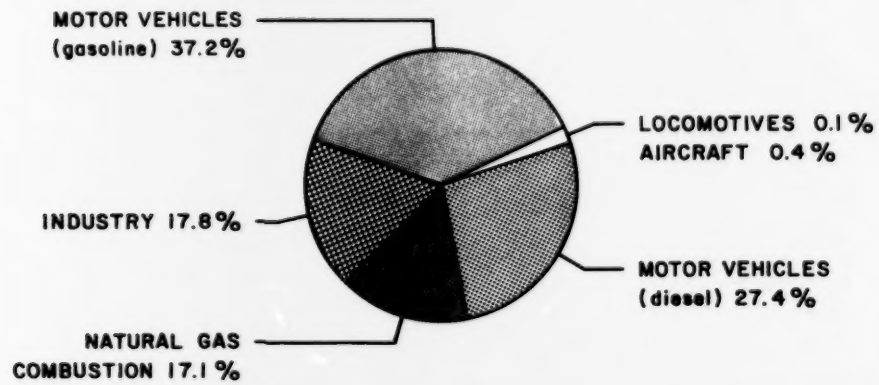
FIGURE 2 - OXIDES OF NITROGEN

NO_2 MONTHLY MEANS



• INSUFFICIENT DATA FOR CALCULATION OF MEAN.

SOURCE AND EMISSION INVENTORY



RELATIVE CONTRIBUTION OF EACH CATEGORY TO TOTAL OXIDES OF NITROGEN EMISSIONS IN THE CITY OF CALGARY, 1973

OXIDES OF NITROGEN 14,536 TONS

Alberta ENVIRONMENT Pollution Control Division

C. OZONE (O_3)

Unlike many other pollutants, ozone is not introduced directly to the air by man's activities. In the upper atmosphere, ozone is a naturally occurring constituent; in the lower atmosphere or ambient air, ozone is the primary end-product of photochemical oxidation involving the nitrogen oxides, ultraviolet light energy and reactive hydrocarbons. Ozone plays an important role in the absorption of harmful ultraviolet radiation in the upper atmosphere; however, in ambient air it can be harmful to humans, vegetation and various materials.

Table 6 and Figure 3 present a summary of the ozone data collected for this report year. The data indicate that:

1. The levels were generally highest during the spring and summer months at all three stations, and
2. The Clean Air (Maximum Levels) Regulation for the 24-hour period was exceeded during the spring and summer at CDMU and CIMU, and throughout the year at CRMU.

The frequent occurrence of readings in excess of the 24-hour Regulation is attributable to the high natural levels of ozone in Alberta constituting what is referred to as background levels. The background levels can fluctuate depending on environmental conditions and can exceed the 24-hour Regulation.[2]

The higher concentrations of ozone recorded at CRMU, relative to CIMU and CDMU, may not be indicative of local sources but may have resulted from wind transportation of the precursors to the residential area. The elevated readings in spring and summer are indicative of the increase in ultraviolet light energy, which enhances the photochemical production of ozone.

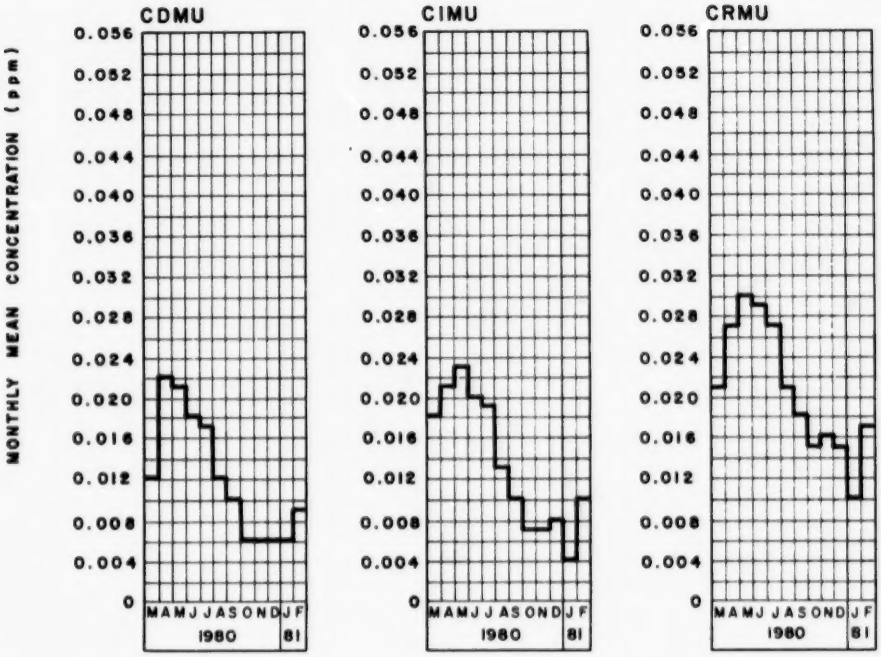
TABLE 6
OZONE

MAXIMUM LEVELS REGULATIONS
1-HOUR-0.080 PPM 24-HOUR-0.025 PPM

MONTH	ARITHMETIC MEAN (ppm)	PERCENTAGE OF TIME INSTRUMENT OPERATIONAL	PERCENT COMPLIANCE WITH REGULATIONS	
			1-HR	24-HR
CDMU				
March '80	0.012	98.7	100	93.5
April	0.022	97.9	100	48.9
May	0.021	98.7	100	64.0
June	0.018	92.8	100	85.6
July	0.017	94.5	100	89.8
August	0.012	99.5	100	100
September	0.010	99.2	100	100
October	0.006	99.3	100	100
November	0.006	99.6	100	100
December	0.006	96.0	100	100
January '81	0.006	99.7	100	100
February	0.009	99.6	100	100
CIMU				
March '80	0.018	98.8	100	87.1
April	0.021	96.8	100	79.3
May	0.023	98.7	100	57.5
June	0.020	93.8	100	92.9
July	0.019	84.5	100	92.4
August	0.013	99.7	100	100
September	0.010	99.4	100	100
October	0.007	99.6	100	100
November	0.007	99.4	100	100
December	0.008	96.5	100	100
January '81	0.004	99.6	100	100
February	0.010	99.7	100	100
CRMU				
March '80	0.021	99.1	100	80.6
April	0.027	99.0	100	29.3
May	0.030	99.5	100	31.9
June	0.029	99.0	99.9	19.2
July	0.027	99.2	100	35.0
August	0.021	99.3	100	74.0
September	0.018	94.0	99.9	85.8
October	0.015	99.7	100	96.8
November	0.016	99.7	100	93.3
December	0.015	99.7	100	90.3
January '81	0.010	99.7	100	100
February	0.017	91.2	100	84.3

FIGURE 3 - OZONE

MONTHLY MEANS



SOURCE AND EMISSION INVENTORY

SINCE OZONE IS PRIMARILY A PRODUCT OF PHOTOCHEMICAL REACTION, THE SOURCE AND EMISSION INVENTORY IS NOT APPLICABLE.

D. CARBON MONOXIDE (CO)

Carbon monoxide is an odourless, colourless gas. It is emitted into the atmosphere in greater quantities than any other urban air pollutant. The majority of the carbon monoxide found in urban air comes from man-made sources. Natural sources, such as forest fires and plant decay, maintain a very low background level.

The 1973 "Source and Emission Inventory" for the city of Calgary (Figure 4) indicates that motor vehicles contribute almost all of the carbon monoxide; therefore, vehicle flow patterns do influence the monitored levels at individual stations.

There were averages of 99.6% compliance and 96.8% compliance respectively with the 1-hour and the 8-hour carbon monoxide Regulations, averaged for all three monitoring stations for the report year. Vehicular traffic exhaust is responsible for the small amount of non-compliance time.

The higher carbon monoxide levels monitored at CDMU, relative to CIMU and CRMU, (Table 7 and Figure 4) are indicative of the vehicular traffic density in the downtown area. Diurnal variations of carbon monoxide levels indicate that peak levels occur during or immediately following peak rush hour periods. The data also indicate that the lowest CO concentrations were monitored during the spring and summer seasons at all three stations. This seasonal variation of CO levels results from changes in meteorological parameters. In the fall and winter, the colder ambient temperatures

result in increased production of CO emissions from motor vehicles. In addition, the more stable atmospheric conditions and low wind speeds, which occur during the fall and winter, result in decreased dispersion of CO emissions and consequently higher ground level CO concentrations, relative to spring and summer concentrations.

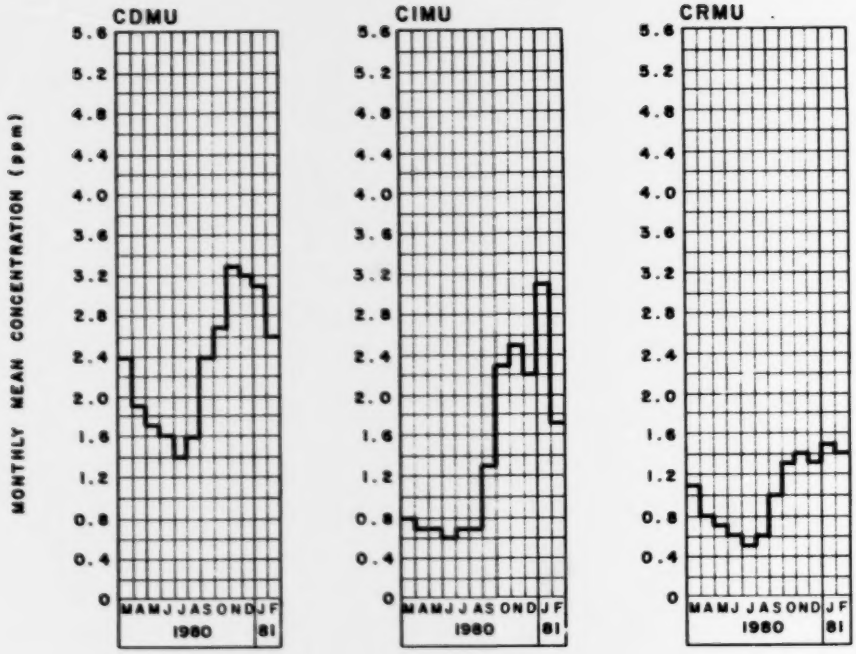
TABLE 7
CARBON MONOXIDE

MAXIMUM LEVELS REGULATIONS
1-HOUR-13 PPM 8-HOUR-5 PPM

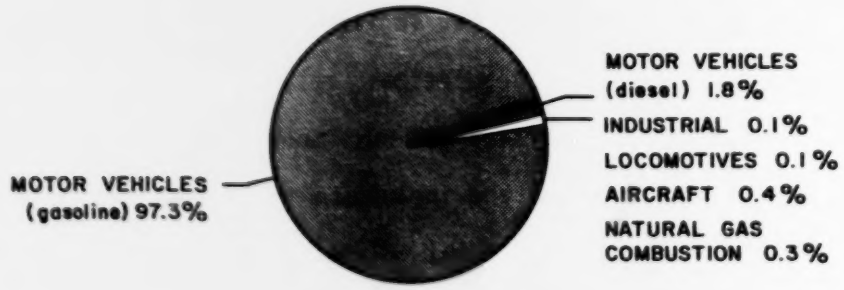
MONTH	ARITHMETIC MEAN (ppm)	PERCENTAGE OF TIME INSTRUMENT OPERATIONAL	PERCENT COMPLIANCE WITH REGULATIONS	
			1-HR	8-HR
CDMU				
March '80	2.4	98.0	100	97.8
April	1.9	95.6	100	100
May	1.7	99.5	100	100
June	1.6	98.5	100	100
July	1.4	87.1	100	100
August	1.6	89.8	100	100
September	2.4	97.4	99.1	97.7
October	2.7	97.4	99.6	92.3
November	3.3	98.5	98.3	80.8
December	3.2	97.6	96.1	84.6
January '81	3.1	98.5	98.1	82.5
February	2.6	99.9	98.4	95.2
CIMU				
March '80	0.8	100	100	100
April	0.7	99.6	100	100
May	0.7	99.2	100	100
June	0.6	94.0	100	100
July	0.7	100	100	100
August	0.7	96.8	100	100
September	1.3	96.8	100	100
October	2.3	97.4	99.6	97.8
November	2.5	99.9	99.4	94.4
December	2.2	100	98.9	91.4
January '81	3.1	90.9	98.2	83.4
February	1.7	99.9	100	98.8
CRMU				
March '80	1.1	97.2	100	100
April	0.8	97.5	100	100
May	0.7	97.2	100	100
June	0.6	96.3	100	100
July	0.5	90.9	100	100
August	0.6	99.7	100	100
September	1.0	99.9	100	100
October	1.3	100	100	100
November	1.4	97.1	99.7	96.6
December	1.3	99.9	99.7	97.8
January '81	1.5	99.9	99.7	94.6
February	1.4	100	100	98.8

FIGURE 4 - CARBON MONOXIDE

MONTHLY MEANS



SOURCE AND EMISSION INVENTORY



RELATIVE CONTRIBUTION OF EACH CATEGORY TO TOTAL CARBON MONOXIDE EMISSIONS IN THE CITY OF CALGARY, 1973

CARBON MONOXIDE
135,098 TONS

E. SULPHUR DIOXIDE (SO_2)

Sulphur dioxide constitutes one of the major air pollutants on a global basis. It may oxidize and combine with moisture to form sulphuric acid and, as such, increase its harmful effects on vegetation and the respiratory systems of humans and animals. When combined with particulate matter, it exerts a synergistic effect that is more harmful than the effect of either pollutant.

Sulphur dioxide pollution results primarily from man-made sources such as combustion of fossil fuels, smelting and roasting of sulphur containing ores, kraft and sulphite wood pulping and sour gas processing. In Alberta, an estimated 295 thousand metric tons of sulphur was emitted into the atmosphere from man-made (primarily industrial operations) sources during 1980. About 51 percent of the sulphur emissions was contributed by sulphur extraction plants; oil sands plants and power plants contributed about 25 percent and 11 percent respectively. The remaining 13 percent came from sources such as gas plant flares, oil refineries, pulp and paper mills and fertilizer plants.[3]

A summary of the sulphur dioxide data collected during the 1980 report period is presented in Table 8. All sulphur dioxide readings were well below the Regulations, resulting in 100% compliance.

Figure 5 illustrates the SO_2 "Source and Emission Inventory" for the Calgary area and includes a graph of total sulphation levels. Although the total sulphation cylinders are static monitors and yield only monthly average values, the data do provide valuable trend information and, therefore, are included in this section.

The lowest total sulphation levels of the period occurred in April (0.11 mg. SO_3 equiv./day/100 sq. cm.), with the highest levels occurring in December, 1980, January, 1981, and February, 1981. All monthly mean concentration levels were below the 0.5 mg. SO_3 equiv./day/100 sq. cm. guideline (Figure 5).

TABLE 8
SULPHUR DIOXIDE

MAXIMUM LEVELS REGULATIONS
1-HOUR-0.17 PPM 24-HOUR-0.06 PPM

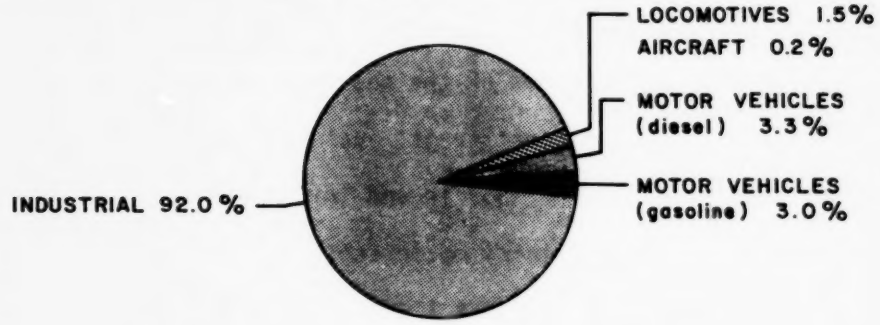
MONTH	ARITHMETIC MEAN (ppm)	PERCENTAGE OF TIME INSTRUMENT OPERATIONAL	PERCENT COMPLIANCE WITH REGULATIONS	
			1-HR	24-HR
CDMU				
March '80	0.00	93.7	100	100
April	0.00	93.1	100	100
May	0.00	97.0	100	100
June	0.00	98.5	100	100
July	0.00	97.0	100	100
August	0.00	94.8	100	100
September	0.00	98.2	100	100
October	0.00	99.2	100	100
November	0.00	99.6	100	100
December	0.00	98.7	100	100
January '81	0.00	93.8	100	100
February	0.00	99.6	100	100
CIMU				
March '80	0.00	94.5	100	100
April	0.00	97.4	100	100
May	0.00	94.2	100	100
June	0.00	96.9	100	100
July	0.00	91.8	100	100
August	0.00	95.8	100	100
September	0.00	98.9	100	100
October	0.00	96.4	100	100
November	0.00	91.1	100	100
December	0.00	88.0	100	100
January '81	0.00	98.0	100	100
February	0.00	95.7	100	100
CRMU				
March '80	0.00	91.3	100	100
April	0.00	95.3	100	100
May	0.00	98.9	100	100
June	0.00	99.2	100	100
July	0.00	98.8	100	100
August	0.00	99.2	100	100
September	0.00	97.4	100	100
October	0.00	99.5	100	100
November	0.00	99.6	100	100
December	0.00	99.2	100	100
January '81	0.00	99.3	100	100
February	0.00	98.7	100	100

FIGURE 5 - SULPHUR DIOXIDE

NOTE

THE MONTHLY MEAN CONCENTRATIONS WERE 0.00 ppm THROUGHOUT THE REPORT YEAR AT ALL THREE STATIONS.

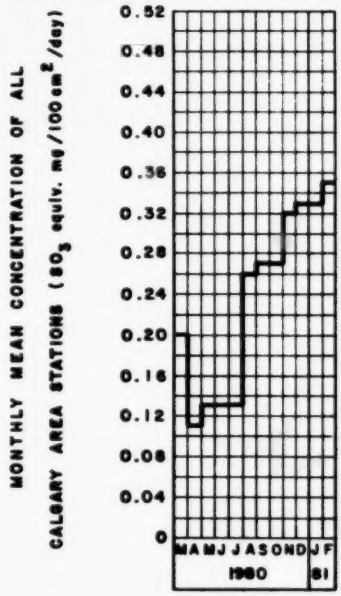
SOURCE AND EMISSION INVENTORY



RELATIVE CONTRIBUTION OF EACH CATEGORY TO TOTAL SULPHUR DIOXIDE EMISSIONS IN THE CITY OF CALGARY, 1973

SULPHUR DIOXIDE
8,661 TONS

MONTHLY MEAN TOTAL SULPHATION LEVELS



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F. TOTAL HYDROCARBONS (THC)

The hydrocarbons considered in this section are those which exist in the atmosphere in the gaseous phase. They are important because they are precursors of compounds formed in the atmospheric photochemical system. Therefore, any assessment of the effects of hydrocarbon pollution must be made in relation to the effects of photochemical air pollution.

The natural sources of the gas-phase hydrocarbons, of which methane is a major constituent, include trees and vegetation. For man-made sources, the "Source and Emission Inventory" (Figure 6) indicates that in Calgary motor vehicles are the primary source with industry contributing about 13 percent. The industrial emissions originate primarily from hydrocarbon storage, whereas the motor vehicle emissions result from inefficient combustion. Inefficient combustion, which occurs before the vehicle reaches operating temperature, is particularly evident during the winter.

The levels of total hydrocarbons monitored during this report period (Table 9 and Figure 6) were lowest at the residential station, CRMU. On a seasonal basis, the highest levels were generally monitored during the winter months and the lowest during the summer months.

Currently there are no air quality Regulations for hydrocarbons.

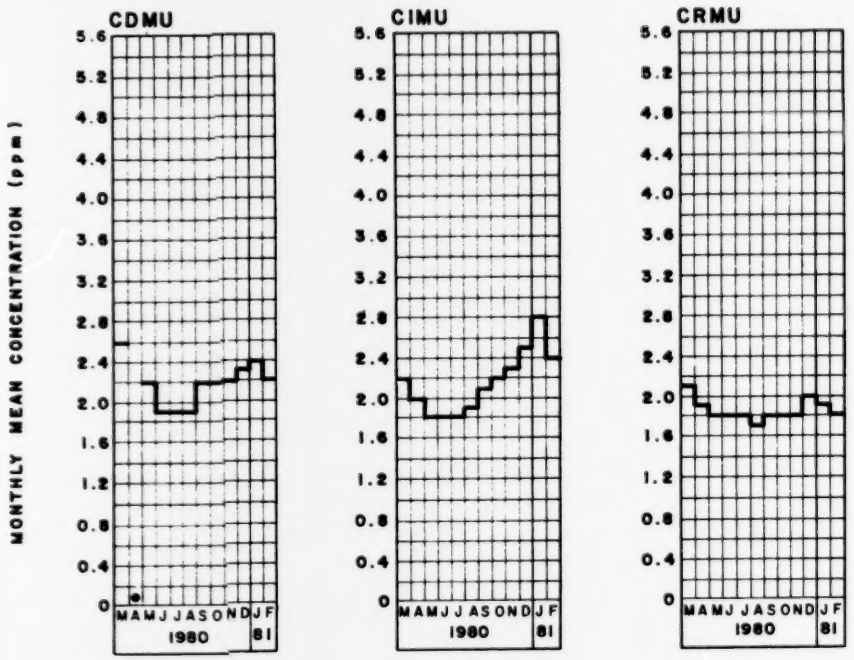
TABLE 9
TOTAL HYDROCARBONS

MONTH	ARITHMETIC MEAN (ppm)	PERCENTAGE OF TIME INSTRUMENT OPERATIONAL	PERCENT COMPLIANCE WITH REGULATIONS	
			1-HR	24-HR
		CDMU		
March '80	2.6[a]	65.5	NO REGULATION	
April	b	20.8		
May	2.2	85.2		
June	1.9	82.2		
July	1.9	96.1		
August	1.9	96.0		
September	2.2	99.3		
October	2.2	90.3		
November	2.2	84.2		
December	2.3	99.7		
January '81	2.4	96.4		
February	2.2	99.9		
		CIMU		
March '80	2.2[a]	71.4	NO REGULATION	
April	2.0[a]	71.5		
May	1.8	99.2		
June	1.8[a]	65.3		
July	1.8	95.6		
August	1.9	84.7		
September	2.1	100		
October	2.2[a]	72.0		
November	2.3[a]	62.5		
December	2.5	99.9		
January '81	2.8	98.9		
February	2.4	90.0		
		CRMU		
March '80	2.1	90.9	NO REGULATION	
April	1.9	86.0		
May	1.8	95.7		
June	1.8	99.7		
July	1.8	99.5		
August	1.7	99.6		
September	1.8	99.7		
October	1.8	100		
November	1.8[a]	68.6		
December	2.0	89.2		
January '81	1.9	99.9		
February	1.8	100		

a - Instrument operational less than 75%; monthly mean may not be representative.
b - Instrument operational less than 50%; insufficient data for calculation of mean.

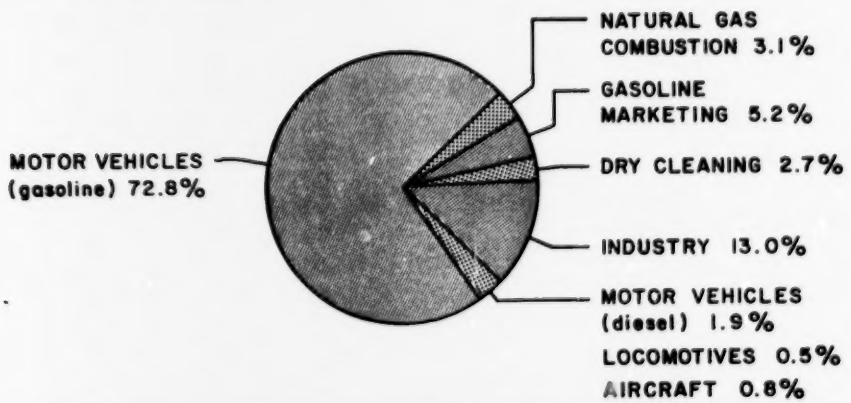
FIGURE 6 - TOTAL HYDROCARBONS

MONTHLY MEANS



• INSUFFICIENT DATA FOR CALCULATION OF MEAN.

SOURCE AND EMISSION INVENTORY



RELATIVE CONTRIBUTION OF EACH CATEGORY TO TOTAL HYDROCARBON EMISSIONS IN THE CITY OF CALGARY, 1973

HYDROCARBONS 22,661 TONS

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G. PARTICULATES

Particulate matter is composed of a wide variety of substances and encompasses any matter dispersed in the air where the individual particles are smaller in diameter than 500 microns (μ). It is the most commonly perceived form of pollution, often manifesting itself by interference with visibility, a soiling effect on materials or as a respiratory irritant. The characteristics of particles and particle dispersion are shown in Figure 7.

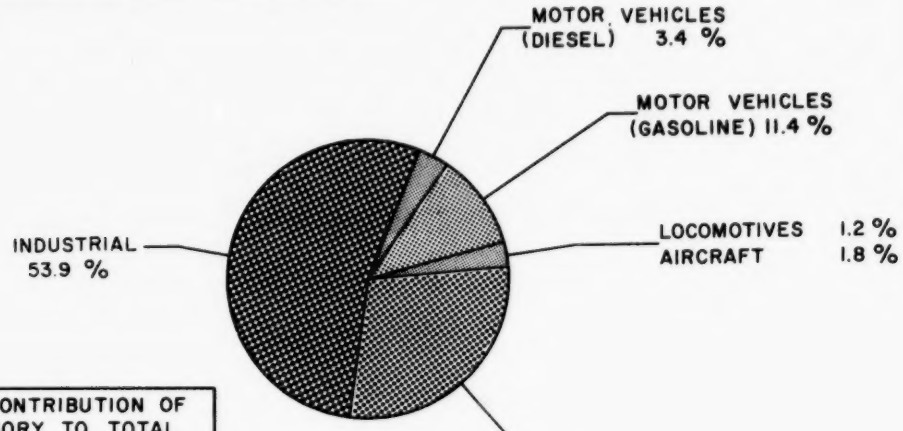
The "Source and Emission Inventory" (Figure 7) indicates that industry is the primary source of particulate emissions with natural gas combustion contributing about 28 percent. Dust from sources such as wind erosion and construction activities is not included in this inventory, although it may in fact be the greatest overall source.

In the city of Calgary, three types of sampling units are employed to measure particulate matter; therefore, the results for each type will be discussed separately in subsequent sections. The three types of samplers are the tape sampler, the high-volume sampler and the dustfall cylinder. The first two samplers measure suspended particulate matter while the latter measures total dustfall.

In general, particles smaller than 1 μ in diameter originate in the atmosphere, principally through condensation and combustion. Particles between 1 μ and 10 μ in diameter usually include soil, process dusts and combustion products from industries. Particles larger than 10 μ in diameter generally result from mechanical processes such as wind erosion, grinding, spraying and the pulverizing of materials by vehicles and pedestrians.[4]

FIGURE 7 - TOTAL PARTICULATES

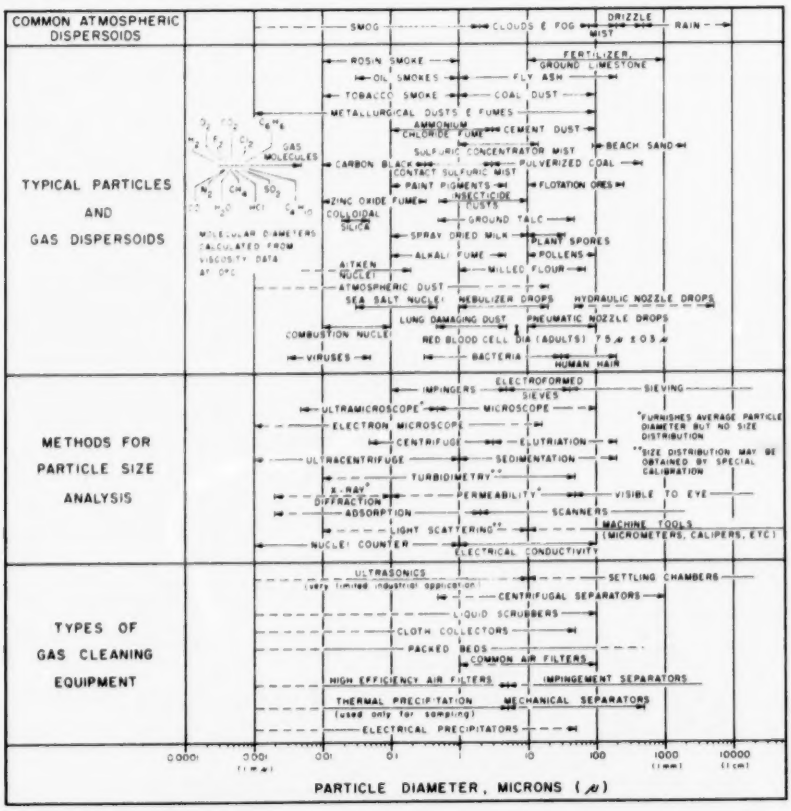
SOURCE AND EM'SSION INVENTORY



RELATIVE CONTRIBUTION OF EACH CATEGORY TO TOTAL PARTICULATE EMISSIONS IN THE CITY OF CALGARY, 1973

PARTICULATES 3,994 TONS

CHARACTERISTICS OF PARTICLES AND PARTICLE DISPERSION



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G. 1. SOILING INDEX

Soiling index is the usual index of suspended particulate matter in the size range of 0.1 μ to 10 μ. It is not a measure of absolute concentrations as the method of analysis does not measure the deposited mass.

The types of suspended particulate matter identified as soiling index include smoke and fine dust particles. The samples are collected by drawing sample air through a filter paper over sampling cycles of one or two hours. The soiling properties of the sample are measured by the reduction of light transmission through the filter paper. This reduction is reported as a coefficient of haze (COH) per 1,000 linear feet of air sampled.

The soiling indices for this report year are summarized in Table 10. The guideline that "a minimum of 90% of readings per month shall be less than 1.0 COH" was complied with by all stations during the report period, except at CIMU in January, 1981, when the average reading was 0.9% out of compliance. The lowest average levels for the report period were recorded during the summer months with CRMU recording the lowest levels (Figure 8).

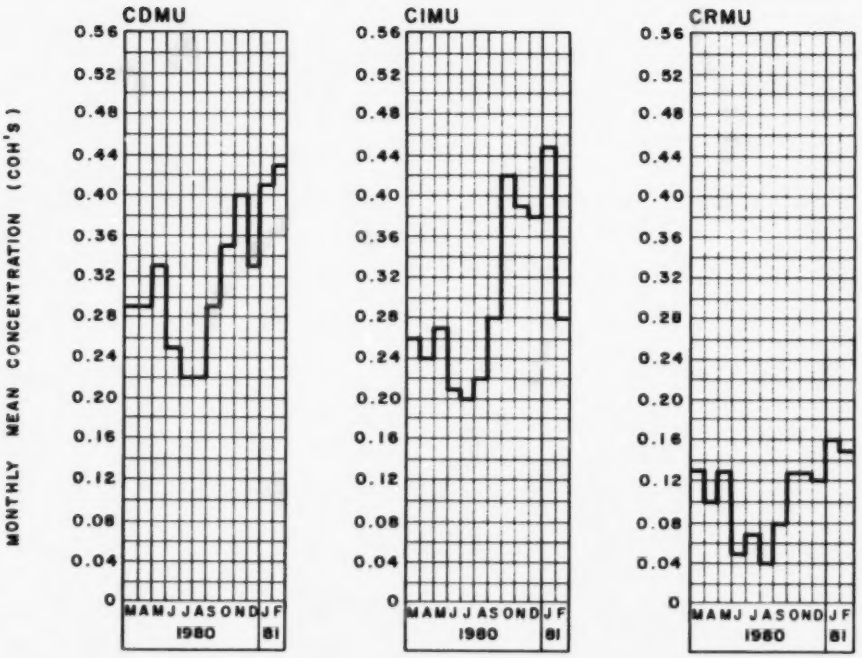
TABLE 10
SUSPENDED PARTICULATE MATTER/SOILING INDEX

GUIDELINE FOR SOILING INDEX
MINIMUM OF 90% OF READINGS PER MONTH
SHALL BE LESS THAN 1.0 COH

MONTH	ARITHMETIC MEAN (COH)	PERCENTAGE OF TIME INSTRUMENT OPERATIONAL	PERCENT OF READINGS LESS THAN 1.0 COH
		CDMU	
March '80	0.29	100	100
April	0.29	98.3	99.2
May	0.33	100	98.1
June	0.25	99.4	100
July	0.22	100	99.9
August	0.22	100	99.7
September	0.29	100	97.4
October	0.35	99.5	97.3
November	0.40	99.4	96.4
December	0.33	100	95.2
January '81	0.41	98.8	92.5
February	0.43	91.5	95.1
		CIMU	
March '80	0.26	97.4	99.0
April	0.24	100	99.0
May	0.27	99.9	98.8
June	0.21	94.3	100
July	0.20	83.7	99.2
August	0.22	100	98.5
September	0.28	91.9	96.5
October	0.42	99.2	92.5
November	0.39	97.1	91.8
December	0.38	94.2	91.7
January '81	0.45	100	89.1
February	0.28	100	96.6
		CRMU	
March '80	0.13	100	99.7
April	0.10	100	100
May	0.13	100	100
June	0.05	100	100
July	0.07	100	100
August	0.04	100	100
September	0.08	100	99.9
October	0.13	98.8	100
November	0.13	95.8	99.3
December	0.12	100	99.2
January '81	0.16	99.1	98.9
February	0.15	100	99.0

FIGURE 8 - SOILING INDEX

MONTHLY MEANS



G. 2. HIGH-VOLUME SAMPLER

Suspended particulate matter is also measured by the high-volume sampler. The sampler consists of a vacuum system and filter housed in a shelter. Suspended particulate matter in the atmosphere is determined by collecting 24-hour samples on the pre-weighed filter. The filter is then reweighed to determine the mass of the particles collected. This method gives a more accurate measurement of suspended particulate matter than the soiling index monitor.

The size of particles collected by the high-volume sampler range from 0.1 μ to 10 μ.

The levels of suspended particulate matter measured by the high-volume sampler (Table 11 and Figure 9) were occasionally in excess of the Clean Air (Maximum Levels) Regulation of 100 $\mu g/m^3$/24-hour at all three stations. On a seasonal average basis, the lowest levels were generally recorded during the fall and winter.

There was an average of 35.2% compliance with the Regulation for suspended particulate matter, averaged for all three monitoring stations over the report year. Blowing dust from roads, surrounding fields, construction sites, gardens, etc. are sources which could have contributed to the periods of non-compliance.

TABLE 11
SUSPENDED PARTICULATE MATTER/HIGH-VOLUME SAMPLER

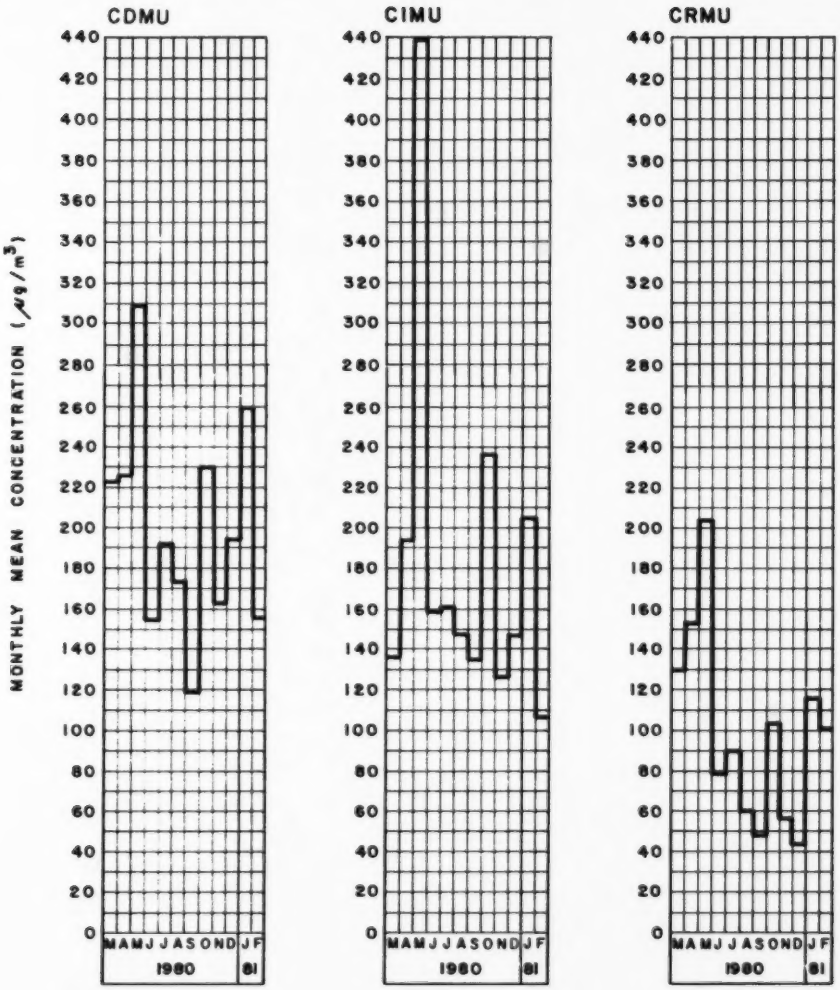
MAXIMUM LEVELS REGULATIONS
24-HOUR-100 $\mu g/m^3$

MONTH	ARITHMETIC MEAN ($\mu g/m^3$)	PERCENTAGE OF TIME INSTRUMENT OPERATIONAL	PERCENT COMPLIANCE WITH REGULATION
		CDMU	
March '80	224	100	20
April	226	100	0
May	309	100	20
June	155	100	20
July	192	100	0
August	174	100	17
September	119	100	60
October	230	100	0
November	164	100	40
December	195	100	60
January '81	260	100	20
February	156	100	20
		CIMU	
March '80	136	80	25
April	194	80	0
May	439	100	20
June	159	100	0
July	161	100	20
August	148	100	17
September	135[a]	60	33
October	237	100	0
November	127	80	50
December	147	80	50
January '81	205	100	20
February	107	100	40
		CRMU	
March '80	130	100	40
April	154	80	25
May	204	100	20
June	79	100	80
July	90	100	60
August	60	100	100
September	48	100	100
October	104	80	50
November	57	100	100
December	44	80	75
January '81	116	100	40
February	101	100	40

a - Instrument operational less than 75%; monthly mean may not be representative.

FIGURE 9 - SUSPENDED PARTICULATE MATTER: HIGH - VOLUME SAMPLER

MONTHLY MEANS



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G.3. TOTAL DUSTFALL

Total dustfall includes particles in the size range greater than 10 μ. Since these particles have appreciable settling capabilities, they are collected by deposition in a dustfall jar or cylinder. The dustfall cylinders are generally exposed for 30-day periods and yield integrated dustfall values for that period.

The large particles collected by dustfall cylinders settle readily at low velocities. Therefore, total dustfall cylinders provide a measure of dust arising from local sources. Quite often high dustfall levels are attributable to nearby construction or vehicular traffic on a dusty road.

The results of the monitoring of total dustfall during the 1980 report period are presented in Table 12 and Figure 10. The readings are actual measured levels and are not corrected for "normal background levels." The data indicates that the lowest levels were monitored during the fall and winter months at both the residential-recreational area stations, and the commercial-industrial area stations.

When the total dustfall levels are compared with the Clean Air (Maximum Levels) Regulations, which distinguish between residential-recreational (53 mg/100 cm^2/30 days) and commercial-industrial (158 mg/100 cm^2/30 days) areas, a high frequency of readings in excess of the Regulations is noted in the residential-recreational area.

There were averages of 48.7% compliance and 89.0% compliance respectively with the residential/recreational area and the commercial/industrial area total dustfall Regulations. Blowing dust from roads, surrounding fields, construction sites, gardens, etc. are sources which could have contributed to the periods of non-compliance.

TABLE 12
TOTAL DUSTFALL

MAXIMUM LEVELS REGULATIONS
53 mg/100 cm^2/30 days in residential and recreational areas.
158 mg/100 cm^2/30 days in commercial and industrial areas.

MONTH	ARITHMETIC MEAN (mg/100 cm^2/ 30 days)	PERCENTAGE OF STATIONS REPORTING DATA	PERCENTAGE OF STATIONS IN COMPLIANCE WITH REGULATIONS
RESIDENTIAL AND RECREATIONAL AREA STATIONS			
March '80	53	94.1	62
April	58	94.1	62
May	113	88.2	0
June	88	100	30
July	63	100	41
August	88	94.1	25
September	55	94.1	56
October	55	94.1	56
November	49	88.2	53
December	54	94.1	69
January '81	54	94.1	69
February	48	100	59
COMMERCIAL AND INDUSTRIAL AREA STATIONS			
March '80	63	100	100
April	118	100	73
May	206	100	64
June	117	90.9	90
July	102	100	82
August	127	100	82
September	82	90.9	90
October	82	90.9	90
November	48	81.8	100
December	51	100	100
January '81	51	100	100
February	51	100	100

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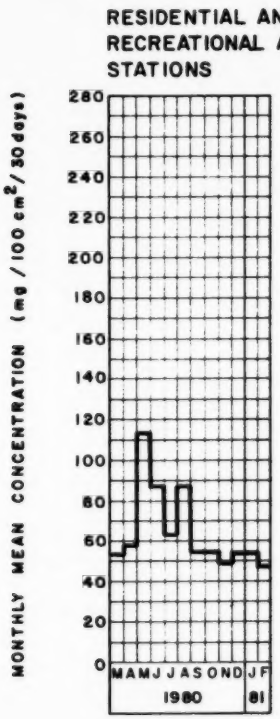
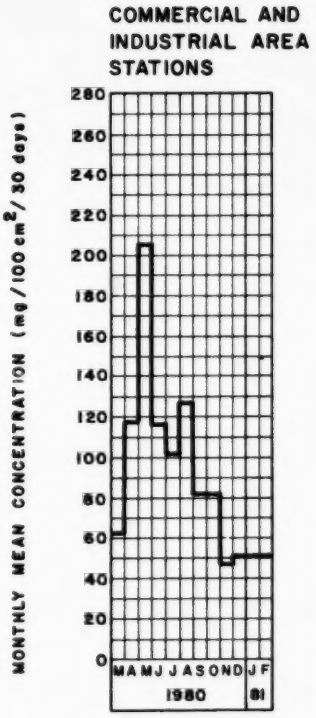
FIGURE 10 - TOTAL DUSTFALL

MONTHLY MEANS





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V. METEOROLOGICAL DATA

Air pollution levels depend upon atmospheric stability and wind. Stable air near the ground is modified by the input of heat from the city and heat from the sun. Pollutants tend to become uniformly distributed in this modified region which is called the "mixing layer". The height of the mixing layer and the mean wind speed determine the "ventilation", which may be viewed as the effectiveness of pollutant dispersal with respect to urban area sources. Poor ventilation, known also as "stagnation", leads to an increase in pollutant concentrations. Good ventilation will keep the concentrations low.

During the night, the surface of the earth loses heat to space and cools the air immediately above it, forming the nocturnal radiation inversion layer in which the temperature increases with height. The height of this inversion and its intensity control the development of the mixing layer.

A tower at the Calgary Industrial Monitoring Unit is equipped to measure the wind at 92 metres and the temperature gradient between 10 metres and 92 metres. The diurnal behavior of temperature gradient and wind for the Spring of 1980 is shown in Table 13. (The tower was decommissioned in June owing to the age and condition of the instruments.) Positive values of the temperature gradient indicate temperature inversions, with little mixing; the negative values correspond to a mixing situation. On the average, there is a well-defined cycle. An inversion is present overnight but after sunrise this weakens and is replaced by a mixing layer in about

three hours. The mixing lasts throughout the day, reaching a maximum one to two hours after solar noon. At sunset, the mixing weakens and about an hour later the inversion returns. Because the cycle is controlled by solar heating, the mixing is strongest in the summer and weakest in the winter.

TABLE 13

DIURNAL BEHAVIOR OF METEOROLOGICAL CONDITIONS

SPRING 1980

CIMU

HR	MEAN TEMPERATURE GRADIENT (°C/100m)	AVERAGE WIND SPEED (m/s)	MOST FREQUENT DIRECTION
1	1.78	5.0	N
2	1.85	4.6	N
3	2.02	4.2	N
4	1.90	4.4	N
5	1.78	4.1	N
6	1.84	4.1	N
7	1.44	3.9	N
8	.44	3.6	N
9	- .49	3.8	N
10	-1.18	4.2	N
11	-1.52	4.7	N
12	-1.72	5.2	N
13	-1.87	5.3	N
14	-2.07	5.2	S
15	-1.53	5.5	S
16	-1.40	5.7	S
17	-1.28	5.8	S
18	-1.21	5.7	S
19	- .98	5.8	S
20	- .51	5.7	S
21	.22	5.6	S
22	.84	5.4	S
23	1.27	4.9	S
24	1.58	4.7	SW

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VI. INDEX OF THE QUALITY OF THE AIR (IQUA)

IQUA, introduced in December 1979, is the new way of expressing the air quality index. It is based on the 1-hour and 24-hour concentrations of nitrogen dioxide, sulphur dioxide, and soiling index (COH), on the 1-hour and 8-hour concentrations of carbon monoxide, and on the 1-hour concentrations of ozone. However, instead of calculating a composite index of all five pollutants, as in the old index, an index is now calculated for each of the five pollutants. The maximum index is then used as the numerical value of IQUA. An IQUA reading of 0-25 indicates good air quality, 26-50 is fair, 51-100 is poor and greater than 100 is very poor.

In Calgary, the IQUA is calculated at three locations: CDMU, CRMU and CIMU, with the index made available to the media and public routinely. It is generally issued at 0800 and 1600 hours on weekdays, except when the index values are greater than 50. In the latter case, it is generally issued every hour until the index value falls below 50.

A summary of the air quality indices for the three monitoring stations is presented in Table 14. During the report year, the air quality was generally good (0-25 as an arithmetic mean). On occasion, however, index values in the 'very poor' category were observed especially during the fall and winter at CDMU and CIMU. Such values were usually a result of high soiling index levels (1-hour average) or carbon monoxide levels (8-hour average).

TABLE 14

INDEX OF THE QUALITY OF THE AIR (IQUA)

	CDMU	CIMU	CRMU
MONTH	ARITHMETIC MEAN	ARITHMETIC MEAN	ARITHMETIC MEAN
March '80	24	17	14
April	22	16	15
May	21	17	17
June	16	14	15
July	15	14	15
August	15	13	13
September	19	15	13
October	22	22	12
November	24	22	13
December	21	21	12
January '81	25	25	13
February	23	16	14

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VII. SUMMARY AND CONCLUSIONS

From the foregoing analysis of the data, the following can be concluded:

1. During the report year the air quality index in the Calgary area was generally in the "good" index range (0-25 as an arithmetic mean).
2. All nitrogen dioxide readings were 100% in compliance with the Regulations, with the exception of 99.9% compliance with the 1-hour Regulation at CDMU in March 1980 and October 1980, and at CRMU in October 1980. Vehicular traffic exhaust is responsible for the small amount of non-compliance time.
3. High natural background ozone levels in Alberta resulted in a significant number of readings in excess of the 24-hour ozone Regulation. There was 83.6% compliance with the 24-hour ozone Regulation, averaged for all three monitoring stations for the report year. Good compliance was achieved with the 1-hour ozone Regulation (average of 99.99% compliance for all three monitoring stations for the report year).
4. There were averages of 99.6% compliance and 96.8% compliance respectively with the 1-hour and the 8-hour carbon monoxide Regulations, averaged for all three monitoring stations for the report year. Vehicular traffic exhaust is responsible for the small amount of non-compliance time.
5. All sulphur dioxide readings were well below the Regulations, resulting in 100% compliance.

6. All soiling index (coefficient of haze-COH) readings were 100% in compliance with the Alberta guideline, with the exception of January 1981 at CIMU, when the average reading was 0.9% out of compliance.

7. There was an average of 35.2% compliance with the Regulation for suspended particulate matter (0.1 μ to 10 μ size range), averaged for all three monitoring stations over the report year. Blowing dust from roads, surrounding fields, construction sites, gardens, etc. are sources which could have contributed to the periods of non-compliance.

8. There were averages of 48.7% compliance and 89.0% compliance respectively with the residential/recreational area and the commercial/industrial area total dustfall (greater than 10 μ size) Regulations. Blowing dust from roads, surrounding fields, construction sites, gardens, etc. are sources which could have contributed to the periods of non-compliance.

VIII. REFERENCES

1. U.S. Department of Health, Education, and Welfare. Air Quality Criteria for Nitrogen Oxides. (NAPCA Publication No. AP-84. Washington, D.C., January 1971); sec. 11, p. 8.

2. Alberta Environment, Research Secretariat. A Study of Photochemical Air Pollutants in the Urban Airsheds of Edmonton and Calgary, H. S. Sandhu. (Staff Report #1. Edmonton, Alberta, 1975).

3. Alberta Environment. Industrial Sulphur Emissions for Alberta 1977-1981, prepared by Alberta Environment, Pollution Control Division, Air Quality Control Branch. September, 1982.

4. U.S. Department of Health, Education, and Welfare. Air Quality Criteria for Particulate Matter. (NAPCA Publication No. AP-49. Washington, D.C., January 1969); p. 181.